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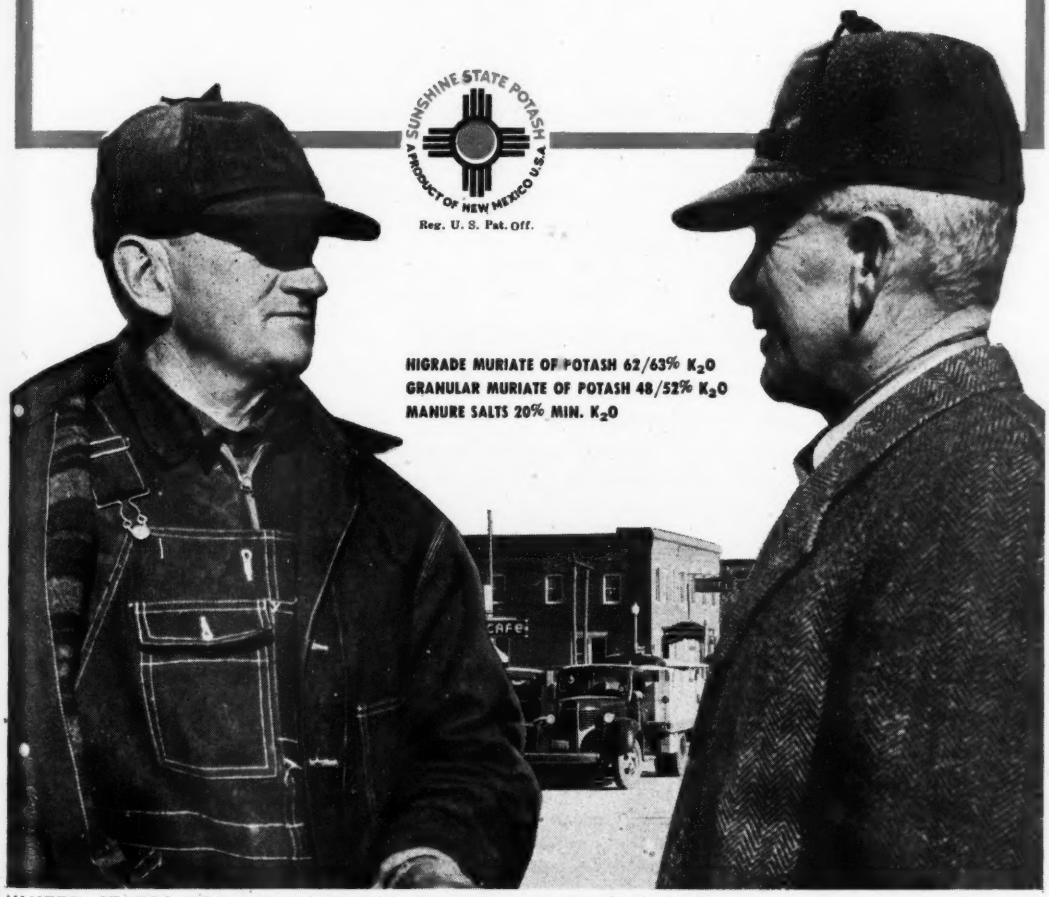

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The American FERTILIZER

Vol. 110 MARCH 5, 1949 No. 5

Mineral and Nitrogen Nutritional Relationships in Plants and Soil*

By JACKSON B. HESTER

Soil Technologist, Campbell Soup Co., Riverton, New Jersey

THE question of the nitrogen and mineral relationships in soils and plants in efficient crop production is extremely important. One element out of balance in proportion to other elements may affect the absorption of any or all other elements by the plant and consequently influence crop production. It is difficult to isolate the subject of nutrient relationships from the correction of deficiency conditions because much of the work that has been done has been in the light of correcting deficiencies in the plant that develop under given soil conditions. In other words, in many instances when a deficiency shows up in a crop this deficiency is corrected and, as each deficiency occurs, correction is made without due consideration of the influence of these and other elements in the soil upon the plant.

Speaking practically, two fields of delicately balanced crops like tomatoes or tobacco may appear to be making identical growth, but when the final harvest is made both the yield and the quality may be different. Apparently these fields may have received identical treatment, but internal relationships in regard to nutritional status offer about the only explanation for their difference in yield. Considerable work has been done by plant physiologists, botanists and other scientists in establishing the nutritional balance for various plants under different conditions. It is not possible in a short article to properly interpret the information disclosed by these investigations. Therefore, it is proposed to divide this subject into three practical fields and discuss personal experiences and investigations. The fields involved are as follows:

1. Interrelationship of elements in fertilizers
2. Interrelationship of elements in soils
3. Interrelationship of elements in plants

There are some 15 different elements deemed to be necessary for crop production. However, a number of other elements absorbed by the plant influence the growth of the plant and the health and well-being of the animals depending upon plant life. Furthermore, many other elements not involved in animal life actually are absorbed and influence the absorption of different nutrients by the plant. This whole field of research is very intricate and deserves the most meticulous study

Interrelationship of Elements in Fertilizers

In investigations of soil fertility problems it becomes necessary to compound fertilizer mixtures of various grades, analyses and composition. The compounding of fertilizer mixtures adequately and satisfactorily for maintaining different soils in a high state of fertility is not as simple as a hasty reconnaissance of the problem might indicate. For

*Reprinted from "Agronomic Notes" published by the National Fertilizer Association, Washington, D. C.

example, take the question of the phsyiologically neutral, acid or basic fertilizer. Owing to the relative inactivity of dolomitic limestone in a dry fertilizer mixture, it might appear that little effect on the elements in the mixture would result. The results in Table 1 show the influence of dolomitic limestone upon the solubility of phosphoric acid in a 4–10–6 fertilizer mixture.

TABLE 1

THE INFLUENCE OF THE HYDROGEN IONS UPON THE SOLUBILITY OF PHOSPHATES IN A FERTILIZER MIXTURE

Fertilizer Mixture	*Physiological Condition*	*Per Cent* *Water Soluble* P_2O_5	*Per Cent* *Citric Acid Soluble* P_2O_5	*Per Cent* *Insoluble* P_2O_5
4–10–6	Acid	8.13	10.35	0.68
4–10–6	Neutral	4.78	10.34	1.41
4–10–6	Basic	1.38	9.49	2.09

Ordinary fertilizer materials and finely ground dolomite being used, these mixtures were thrown together and after a minimum curing period, reworked and finally sampled for analysis. It is obvious that changing the physiological reaction of the fertilizer from acid to basic results in a definite reduction of water-soluble phosphoric acid and even a reduction of the citric acid soluble. Undoubtedly a longer period of storage under more moist conditions would have influenced the reaction much more. Elements in the ertilizer mixture like manganese, boron, copper and zinc are affected in a similar manner or perhaps even more. On the other hand, elements similar to molybedenum would be influenced reversely. This serves to show how the effect of an ion in the fertilizer mixture influences the solubility of other ions in the mixture and their availability to plants.

Interrelationship of Elements in Soils

The influence that the hydrogen ion concentration in the soil has upon the availability of certain ions has been very well established. For example, the solubility of ions like aluminum, manganese, iron, zinc and copper increases as the acidity of the soil increases. On the other hand, the solubility of such ions as phosphorus, molybdenum and arsenic increases as the acidity of the soil decreases.

With a Sassafras fine sandy loam analyzing approximately *p*H 4.7 and with the *p*H of the soil changed to 6.8 with calcium lime and to 6.4 with dolomitic lime, the readily soluble manganese changed from 47 pounds to 0.8 and 1.2 pounds per acre, respectively. Iron and aluminum were also influenced somewhat similarly, but to a lesser extent. The availability of the phosphoric acid in this same soil was increased from 2.4 pounds to 26.2 and 12.0 pounds per acre, respectively. Similarly, the replaceable calcium in the soil changed from 190 pounds to 4,200 and 1,100 pounds per acre, respectively. This serves to illustrate how the various ions in the soil influence the availability of other ions in the soil. Not only are the cations in the soil influenced very greatly, but if the salts like muriate of potash, sulphate of ammonia, nitrate of soda and superphosphate are used in a soil that is not leached in comparison with fertilizer materials that leave no residue in the soil, such as urea, ammonium nitrate and ammonium phosphate, the accumulation of residual ions such as those of sodium, chloride and sulphate from materials first-mentioned may affect yields.

With a Sassafras sandy loam at Norfolk, Virginia, and fertilizer mixtures made from the above first-mentioned materials, it was demonstrated, after growing three crops, that the yield of potatoes fell in the soil which carried the residual sodium chloride, sodium sulphate and the like. The difference in yield, in relative figures, was 23.6 to 220.4. Not very large amounts of sodium or chlorides are absorbed by most plants even though the content in the soil may be rather high. Consequently, the difference in yield must have been due to the influence of certain ions on the absorption of other plant foods and the utilization by plants. When the soils containing the chlorides, sodium and similar ions were leached, the yields again became comparable.

With truck-crops soils which analyzed high in available phosphoric acid and nitrogen but low in potash, significant increases in yields of sweet potatoes were not obtained with 150 pounds of potash per acre, but with 300 pounds an increase of 85 bushels per acre was obtained. Again, with the Ranger sweet potato in New Jersey the yields from the sue of 1,600 pounds of 3–9–6, 3–9–12 and 3–9–18 were the same on carefully replicated plats. The use of magnesium compounds containing the equivalent of 4 per cent magnesium oxide in a 3–9–12 fertilizer mixture increased the yield from 15,040 to 20,000 pounds per acre in 1947 and from 13,120 to 20,000 pounds per acre in 1947 and from 13,120 to 17,120 pounds in 1948. The magnesium deficiency symptoms that occurred on the veins occurred first on the plats receiving the 3–9–18 fertilizer mixture, second on the 3–9–12 plats, and last on the 3–9–6 plats. The deficiency symptoms were hardly severe enough for the correction to entirely account for the large increase in yield. Con-

(Continued on page 26)

Organic Matter Puts New Life in Old Soils*

By C. J. CHAPMAN

Soils Department, University of Wisconsin, Madison, Wisconsin

LAST fall as I was walking over a farm with the owner, we came to a field where the hired man was plowing under a tremendous growth of mixed sweet clover, alfalfa, and timothy. The owner told me that he had not harvested even the first crop of hay but had saved it for plowing under in the fall as a source of organic matter and humus. We stood there and watched the tractor make several rounds. The plows were doing a marvelous job of turning under this tangled mass of vegetation. It was a good sight to see; it made me feel that here at least was one farmer who really appreciated the importance of restoring his soil with this life-renewing substance—organic matter.

I know that most farmers would have taken this crop of hay. To make hay out of such a fine growth of legumes and grasses and store it in the barn for winter feed is an almost irresistible temptation. Such a crop, harvested and mowed away in the barn is the equivalent of money deposited in the bank. But to me, this crop of organic matter being plowed under was "money in the bank," too. Here was a good farmer, with practices in line with the teachings of such soil scientists as Professor Emil Truog and Dr. Firman E. Bear, both of whom have repeatedly stated that organic matter is a by-product of good farming.

We have been buying and applying a great deal of commercial plant food in the last five or six years. We have poured on millions of tons of lime and hundreds of thousands of tons of fertilizers, and the supply of fertilizer is still short of meeting the demand and need. Our chief objective in recent years has been to grow more feed for more cattle, hogs, and sheep. Most farmers have been harvesting "the last straw." We have been "cashing in," and I am glad that farmers have been making some money. They are entitled to this period of prosperity and good times—we have only to think back to those lean years of the early 30's when farmers literally lived up their capital investment of buildings, farm equipment, and soils as well.

But we have been drawing heavily on our soil resources during the past 6 or 7 years, not only drawing on the plant-food bank account, but burning up the organic matter. True, we have been applying great quantities of lime and fertilizer—three times the amount we were using 10 to 15 years ago! We know that the more liberal use of fertilizers and lime has resulted in bigger crops of hay and grain, more corn fodder, more straw, and more crop residues to plow under. However, we are still "cashing in" on the organic matter reserves of our soils, and have been ever since we started cropping them 75 to 100 years ago.

Organic Matter Vital to Soil

Just how important is organic matter in a program of long-time crop production and soil fertility maintenance? It has been said that organic matter is the life of the soil—that it is the mainspring to productive, fertile soils; and in more recent years we have been hearing a lot about its importance. A bulletin published some 3 or 4 years ago by the National Fertilizer Association, entitled "Organic Matter—the Life of the Soil," presents an excellent discussion of this subject.

Dr. G. N. Hoffer, with his articles dealing with soil ventilation, the damaging effects of soil compaction, and the depletion of organic matter supplies, and in his urging of farmers to grow a larger acreage of deep-rooted legumes which will penetrate these tight subsoils and thus improve their physical condition, has become a nationally recognized authority in this and related fields of soil fertility maintenance.

Just what is the function of organic matter? We all know that it aids in improving the physical properties of soils. Soils abundantly supplied with humus and organic matter are more friable and easier to work. There is probably no task on a farm which gives the farmer more genuine satisfaction than the plowing of land that is mellow, free-working, and friable. Certainly it is true that a soil

*Reprinted from "Better Crops with Plant Foods," January, 1949.

well supplied with humus will not clod, crust, or bake so badly, and in turn, germinating seeds are better able to push through the soil in the spring.

The water-holding capacity of the soil is increased, and by increasing water intake we are reducing water runoff, thereby indirectly helping to control soil erosion.

In the decomposition of organic matter and humus we are releasing essential elements of plant food. In the rotting process, carbon dioxide is released, and this carbon dioxide combined with water forms a weak acid which helps to dissolve from the mineral constituents of our soils other plant-food elements making them available.

Humus Aids Fertilizer Efficiency

Authorities tell us that a soil well supplied with humus and organic matter responds more generously to treatment with commercial fertilizers. In more recent years there has been talk about "hormones" and the relationship of organic matter to these so-called growth factors which are released in the decomposition of vegetable matter in the soil.

Nitrogen, one of the most important plant-food nutrients needed in the growth of crops, is released through the decomposition of organic matter. The supply of soil nitrogen is almost completely in organic form. Most farmers know that a dark-colored soil will usually produce a more abundant growth of crops that are darker green in color. It used to be thought that the darker the soil, the richer the soil; and this is true from the standpoint of the potential supplies of nitrogen.

What can we do to restore our worn and depleted soils with this substance we call humus and organic matter? This is a good time to start because farmers are now in a better position financially to plow in some "bank account reserves" and because we are producing more abundant crops with the present heavy use of fertilizers and lime and we really have something to plow under.

An Organic Program

This matter of building back and maintaining a good supply of organic matter in our soils is a program we should keep at continuously over a period of years. Nevertheless, anything that we do now will have lasting effects. It is true that the organic matter we plow under decomposes rather quickly and does release most of the nitrogen and minerals it contains in a relatively short period; however, there is a residue of rather resistant material called humus, composed largely of organic carbon, that remains in the soil for long periods. The more mature the crop we plow under, the more of this resistant and long-lasting type of lignin-containing humus we add.

Here are a few suggestions for such a program: First, we must apply the plant-food elements needed to grow abundant crops. We should lime every acre of acid soil on our farms. We should take good care of stable manure, using plenty of bedding to absorb the liquid portion, and get this manure back onto the land.

Second, we should rotate our crops and follow through on soil and crop management that will hold down to a minimum losses of soil by wind and water erosion. Such management entails strip cropping, contour cultivation, crop cover, and liberal fertilization.

Third, we need to grow crops not only for the purpose of feeding our livestock but for the purpose of plowing under to restore and energize our soils. Let's not think we must harvest every blade of grass; rather, occasionally plow down a second crop of clover or alfalfa. Better yet, grow sweet clover or other deep-rooted legumes for the sole purpose of plowing under. Whenever possible, sow catch crops such as rye, oats, or buckwheat that will serve first as protection against wind and water erosion in the fall and during the winter months, and which can be plowed under the following spring as a source of humus and organic matter.

Rapid Loss of Organic Matter

I wish now to give expression to what I think are some common sense ideas of how far farmers should go in this matter of organic matter restoration. It's true that the average farmer will have to settle for something in between the extremes of virgin organic matter levels and complete exhaustion.

Virgin soils lose organic matter rapidly after they are broken and cropping practices started. A large part of the accumulation of humus over the period of thousands of years in our virgin prairies can be burned up within a period of relatively few years. When a virgin soil is broken and cropped, the process of decay and rotting takes place at an accelerated rate. In the words of Dr. A. G. Norman, "Bacterial fires burn very rapidly." In other words, we greatly stimulate biological activities by plowing and cultivating. "That organic matter depletion occurs," says Dr. Norman, "is not the result of poor farming but because the annual balance of organic matter in crops over expenditure is so much

(Continued on page 28)

Mathieson Buys Standard Wholesale Phosphate and Acid Works

At a meeting of stockholders of Standard Wholesale Phosphate and Acid Works, Inc., held in Baltimore on March 1st, a total of 138,277 shares voted to accept common stock in Mathieson Chemical Corporation on the basis of 225,000 shares of Mathieson for the 150,000 shares of outstanding Standard stock. Mathieson acquires all of Standard's assets in consideration of assumption of its liabilities, according to an announcement by Thomas S. Nichols, Mathieson president. A total of 143,608 shares of Standard stock were represented at the meeting.

This is the first statement that has been made by the Mathieson management in respect to the Standard purchase. The Mathieson shares involved are authorized but previously unissued common stock.

Standard Wholesale Phosphate produces sulphuric acid, superphosphates and mixed fertilizers. Its Baltimore plant and properties include several recently installed units for the manufacture of sulphuric acid, making it the largest sulphuric acid plant in the world. It has well equipped docking and loading facilities for ocean shipment.

Standard's annual report for the fiscal year ended May 31, 1948, showed current assets of approximately $6,000,000 including $3,300,000 in cash and U. S. Government securities. Current liabilities amounted to $2,130,000. Sales for that fiscal year totaled approximately $11,000,000 and the net profit after taxes was $1,400,000.

Mathieson, which recently announced the acquisition of Southern Acid and Sulphur Co. operating in the southwest, now has a similar business on the eastern seaboard, Mr. Nichols pointed out. In addition to acquiring production and shipping facilities, he said, the Standard transaction will enlarge Mathieson's sales territory for sulphuric acid and fertilizers and provide a new location for the company's chemical developments.

Texas Fertilizer Sales Increase

Sales of fertilizers in Texas during 1948 amounted to 450,882 tons, an increase of 8 per cent over 1947 output of 416,879 tons, according to figures compiled by J. F. Fudge, state chemist. Of the 1948 tonnage, 277,183 tons were sold during the first half of the year and 178,699 during the second half, about the same proportion as in 1947.

Sales were about equally divided between mixed goods and individual materials, showing 218,124 tons of mixed fertilizers and 232 tons of materials. Most of the mixed tonnage was accounted for by two grades: 4–12–4, 96,830 tons and 5–10–5, 93,140 tons. Texas is a heavy user of superphosphate for direct application, 175,506 tons of the 20 per cent grade being sold during 1948. Other leading materials were ammonium phosphate sulphate (16–20–0) 28,810 tons, and ammonium nitrate 11,481 tons.

Maryland Fertilizer Tonnage

The sales of fertilizers in Maryland during 1948 totaled 233,252 tons, a decrease of 8.8 per cent from the 1947 output of 255,949 tons. The figures for the various grades, as compiled by L. E. Bopst, state chemist, show that mixed fertilizers accounted for 212,888 tons, of which 200,740 tons were complete fertilizers and 12,148 tons were superphosphate-potash mixtures. The average plant food content of the complete fertilizers showed slight increases in phosphorus and potash, the nitrogen content remaining unchanged. The average analysis was: N, 3.6 % P_2O_2, 11.9%; K_50, 7.5%.

The number of firms registered during the year increased from 85 in 1947 to 99 in 1948. Analyses registered, however, increased only from 76 in 1947 to 77 in 1948, of which 48 were complete fertilizers, 7 were superphosphate-potash mixtures, and 22 were individual materials.

Sales of the 16 grades recommended by the Maryland Department of Agriculture totaled 198,726 tons, or 93 per cent of the total mixed fertilizers sold. More than half was accounted for by the 3–12–6 grade, of which 109,763 tons were used. Other leading grades were: 5–10–5, 15,485 tons; 4–12–8, 13,926 tons; 4–8–12, 12,963 tons; 6–8–6, 12,831 tons; 3–9–12, 11,524 tons; 0–14–7, 8,857 tons. Sales of individual materials for direct application included: superphosphate (20%), 9,615 tons; superphosphate (18%), 2,502 tons; nitrate of soda, 4,373 tons; cyanamid, 1,078 tons; ammonium nitrate, 667 tons.

The increase in plant food content over the years is indicated by the list of best sellers. From 1913 to 1918, the 1–8–1 mixture held the lead. Succeeding leaders were 2–8–2 (1919–1921); 2–8–5 (1922–1934); 2–9–5, (1935–1939); 2–12–6 (1940–1943); 3–12–6 (1944–1948).

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Principal Articles in This Issue

Indiana Tomato Champion Uses Direct Seeding

Direct seeding of tomatoes has brought good results for Simon Birkey, of Miami County in north-central Indiana. In 1948, he won the Indiana U. S. "Won" tomato club championship with a yield of 21.86 tons per acre on his 4.9 acre field, of which 82 per cent were graded as U. S. No. 1's.

As described in the current issue of "Prarie Farmer," Mr. Birkey is convinced from four year's experience with direct seeding that his method has many advantages over the transplanting system. Primarily he found that direct seeding brought higher yields, a result which was confirmed by other farmers using this method. Sincerely, he avoided introducing diseases from purchased plants. Thirdly, he was able to grow exactly the kind of plants he wanted. And finally, he avoided the problem and expense of living competent labor to set the plants.

Fertility is just as important as plants, Birkey says. Perhaps it is more important than a good job of direct seeding because without fertility the plants cannot grow.

On his farm he likes to precede tomatoes with a good crop of alfalfa. Manure is added, about 12 loads per acre. Liberal amounts of fertilizer are used also. Spring plowed, 1,000 pounds of 3–12–12 fertilizer went under with the alfalfa sod. Then after several workings, the field was direct seeded on April 26. Another 250 pounds per acre of high analysis fertilizer was added at that time.

Direct seeding at the Birkey farm is done with a special tomato seeder that is attached to the corn planter. The seeder follows in the wheel tracks of the planter, thus putting the seeds in a furrow.

One of the secrets of direct seeding is the depth of planting. Plant just so the seeds are covered, Birkey advises.

Plants from direct seeded tomatoes are blocked out when they grow to a height of six inches. Birkey likes to leave a good healthy plant every 30 inches. His blocking has been done by hand, using a garden hoe. Some farmers cross the tomato rows with a corn plow to make the initial "block out," then follow up with a garden hoe.

Summer cultivations included plowing four times. Each cultivation was shallower than the preceding one to keep from injuring the tender feeding roots. Tomatoes were picked from August 24 to October 5.

A Corn-growing Challenge

Everyone knows what the Governor of South Carolina said to the Governor of North Carolina, but now the Governor of Virginia has entered the conversation. At a recent meeting of the 100-Bushels-Per-Acre Corn Club of Prince George County, Virginia, Governor Tuck of that state issued a challenge to Governor Scott of North Carolina for a corn-growing contest during 1949. The winner is to be the state producing the greater increase over its average per-acre yield for the 1937–1946 period.

At the meeting, 84 farmers of Prince George County received certificates for growing more than 100 bushels of corn per acre during 1948. In addition, the six top winners received cash prizes, with first prize going to Lee Price for his record of 200.72 bushels per acre. Mr. Price used a total of 2,250 pounds of fertilizer per acre, plowing under 1,000 pounds per acre of 3–12–6 at planting time. He added another 250 pounds at the second cultivation and side-dressed with 1,000 pounds of nitrate of soda at the fourth and last cultivation.

A. C. S. Fertilizer Division Planning Program

The Division of Fertilizer Chemistry of the American Chemical Society will hold its 41st annual meeting during the sessions of the parent body at Atlantic City, N. J., Septemper 18–23, 1949. A timely divisional program is being arranged by the chairman of the division, Dr. Jackson B. Hester, Soil Technologist of the Campbell Soup Co. Agricultural Research Department, Riverton, N. J.

Dr. Hester has proposed to the division members a program built around the following subjects:

1. Sulphur in Agriculture
2. Trace Elements in the Fertilizer Mixture
   a. The advisability of inclusion
   b. Chemical reaction within the fertilizer mixture
   c. Availability after inclusion
   d. Mechanical difficulties of inclusion
   e. Influence upon plant growth
3. Physical Aspects of Fertilizer Mixtures
4. Fertilizer Sampling
5. Radioactive Isotopes in Fertilizer Work

He will be glad to have suggestions for other timely subjects which would be of interest to the fertilizer manufacture and chemist.

Wisconsin Tonnage Increases

With sales of 404,121 tons during 1948, fertilizers used in Wisconsin showed an increase of almost 11 per cent over the 367,178 tons used in 1947, according to figures compiled by W. B. Griem, of the Wisconsin Department of Agriculture.

Complete fertilizers accounted for 254,720 tons; phosphate-potash mixtures, 100,897 tons; superphosphate, 20,663 tons; other materials, 27,841 tons.

Of the total tonnage, 10,949 tons were superphosphate distributed by the Federal Production and Marketing Administration, the balance being commercial distribution.

Of the 38 grades of mixed fertilizers sold during the year, the 3–12–12 analysis accounted for 124,441 tons, almost half of the mixed fertilizer total. The next best sellers were: 2–12–6, 57,825 tons; 0–20–10, 43,083 tons; 4–12–8, 29,654 tons; 0–14–7, 19,285 tons; 0–12–12, 17,047 tons; 3–28–9, 12,447 tons. In addition to superphosphate previously mentioned, other materials applied directly included: ammonium nitrate, 12,734 tons; rock phosphate, 8,369 tons; organics, 2,889 tons; potash salts 1,357 tons.

The progress made in fertilizer usage in Wisconsin is indicated by the fact that the 1948 tonnage represents an increase of 428 per cent over the 76,529 tons sold in 1941.

Kenaf, New Jute Substitute, Shows Promise

Kenaf, a fiber crop new to the Western Hemisphere, is now being grown successfully in Cuba and El Salvador as a result of collaborative work between agricultural scientists of the United States and Latin American countries, the U. S. Department of Agriculture has reported.

The new source of fiber promises to be of unusual value, both commercially and strategically. It is an effective substitute for jute fiber (a principal source of cordage and bagging material), which normally is imported from India and Pakistan. Jute, during recent years, has been in increasingly short supply because of conditions in the producing areas of India and Pakistan, a major one being that more of their land is going into food crops.

With the expected commercialization of Kenaf, which is now in pilot plant production, several benefits will accrue to Western Hemisphere participants, according to the Office of Foreign Agricultural Relations which has been

active in the development. One benefit is the greater security from having a fiber source close at hand. Another would be reflected in the additional opportunities for income in the kenaf producing countries. Cuba, for example, which uses around $20,000 worth of sugar bagging yearly, has found that the kenaf season dovetails nicely with the sugar season, giving new opportunities for employment during what otherwise would be slack periods.

The importance to the United States of a fiber such as kenaf is indicated by the great quantities of jute and jute products including bags, cordage, and burlap, that are imported from the Far East. Most of the imports are received indirectly in the form of bags containing sugar, coffee, cacao, and other imported agricultural products. Raw fiber of the kenaf type is important to United States manufacturers of hooked rugs, carpeting, twines, burlap, bags, electric cables, and oakum. For products such as these, kenaf is an effective substitute for jute.

Fertilizer Recommendations for Connecticut

At a recent meeting of Connecticut county and 4-H club agents, held at the state agricultural experiment station, Dr. Arthur Hawkins, extension potato specialist, gave general fertilizer recommendations for potato land in the state, based on the effect previous land use has on nitrogen, phosphorus and potash supply. In general, he said, nitrogen is usually deficient when land has been planted to potatoes or other cultivated crops for several years, or when potatoes follow strawy crops, such as mature rye or millet. Phosphorus and potash are usually deficient in virgin soils, such as newly cleared woodland or land that has been in pasture for several years.

E. C. Minnum of the University of Connecticut, discussed minor soil element deficiencies in vegetable fields, emphasizing particularly the prevalence of boron deficiency in many Connecticut fields last summer. The remedy is borax applications, broadcast, and not put on in bands. Both Dr. Hawkins and Mr. Minnum stressed the importance of soil tests before making fertilizer applications to fields.

January Sulphate of Ammonia

There was little change in the production figures of by-product sulphate of ammonia produced during January, according to the report of the U. S. Bureau of Mines. The January output of by-product material was 73,990 tons, compared with 74,222 tons in December, 1948. In addition, the by-product producers manufactured 4,327 tons from purchased synthetic ammonia. These latter figures do not include the output of sulphate of ammonia by other chemical manufacturing companies which do not operate by-product coke ovens. Shipments during the month were about equal to production, leaving stocks on hand at producing plants on January 31st of 24,705 tons.

SULPHATE OF AMMONIA

	By-Product Tons	Synthetic Tons	Ammonia Liquor Tons NH_3
PRODUCTION			
January, 1949..	73,990	4,327	2,156
December, 1948	74,222	3,685	2,133
January, 1948..	71,875	2,257	2,094
SHIPMENTS			
January, 1949..	73,494	4,107	1,666
December, 1948	77,605	3,588	1,460
January, 1948..	68,645	2,316	1,782
STOCKS ON HAND			
Jan. 31, 1949...	24,705*		645
Dec. 31, 1948..	23,927*		448
Jan. 31, 1948...	31,538*		1,577

*Includes by-product and synthetic stocks on hand.

FERTILIZER MATERIALS MARKET

NEW YORK

Some Shipping Difficulties on Sulphate of Ammonia. Demand Still Heavy for All Chemical Nitrogen. Organic Prices Drop with Some Purchases by Fertilizer Trade Reported. Superphosphate Stocks Still Heavy but Increased Shipments Expected. No New Foreign Potash Shipments Reported

Exclusive Correspondence to "The American Fertilizer"

NEW YORK, March 2, 1949.

Sulphate of Ammonia

Some producers experienced some difficulty in securing necessary box cars but, as a whole, shipments were being made in an orderly fashion against contracts. Demand was excellent from all sections. Some small producers are advancing the price $2.00 per ton, effective March 1st.

Nitrate of Soda

Both domestic producers and the importers were making regular shipments on an allocated basis and the demand has increased in the last week for quick shipment.

Ammonium Nitrate

Numerous inquiries for this material brought out no offerings as the shippers were all under contract. Demand continued heavy from various sections.

Nitrogenous Tankage

This material was only in fair demand and supplies were plentiful enough to fill any orders that might be placed. Some shippers were reported sold out for nearby shipment.

Castor Pomace

With producers willing to sell this material at $24.00 per ton, f.o.b. production points, some fertilizer buyers showed more interest due to the reduced price and some fair sized orders were received.

Organics

The organic market was rather weak, due to the slowness in the feed trade, and most of the feed materials were lower in price. Tankage and blood sold at $7.50 per unit of ammonia ($9.12 per unit N) f.o.b. Eastern shipping points, with additional supplies offered at this figure. Most feed buyers decided to remain out of the market but, as some of the prices declined, some fertilizer buyers showed more interest and some sales were made to the fertilizer trade. Soybean meal and cottonseed meal were obtainable for quick shipment at $53.00 per ton and $56.00 per ton respectively, f.o.b. production points, with little buying interest.

Fish Meal

A large quantity of fish scrap was reported sold on a "when and if made" basis for April, May delivery at around $125.00 per ton f.o.b. production points, and some fish meal was sold at $140.00 per ton. Spot fish meal for quick shipment has sold at $175.00 per ton and the demand is excellent, due to the scarcity of supplies.

Bone Meal

This material was almost impossible to buy due to the scarcity, and leading producers were sold out for the rest of the season. Production is off at most plants, which has increased the shortage. Raw bone meal was in demand from various areas.

Superphosphate

With the heavy fertilizer shipping season at hand, producers expect to cut down their available stocks and shipping instructions are being received in good volume. Some price shading was reported if a buyer was willing to take on a good-sized quantity.

Potash

No word was received of any additional offerings of foreign potash and it is reported that some of the material that might have been shipped here from abroad had been shipped to Japan instead. Domestic producers were busy shipping against contracts.

CHARLESTON

Better Movement of Superphosphate. Demand Still above Supply on Chemical Nitrogen and Potash. Organics Prices Lower

Exclusive Correspondence to "The American Fertilizer"

CHARLESTON, February 28, 1949.

Superphosphate is moving in seasonal dimensions with adequate supplies of normal grades. Potash shipments are on schedule but supplies are insufficient to meet the entire demand. The nitrogen supply continues short of demand with little prospect of easement this season.

Organics.—Demand for organics by the feed trade in recent weeks has slackened, resulting in lower prices on blood and tankage. Nitrogenous tankage is obtainable at $3.00 to $4.00 per unit of ammonia ($3.65 to $4.86 per unit N), in bulk, f.o.b. producer's shipping point, depending on its location. Imported organics continue at levels above domestic buyer's views.

Castor Pomace.—In recent weeks this material has sold at $21.00 per ton in bags, f.o.b. Northeastern production points but producers are in a sold-up condition for the present. Movement is primarily against existing contracts.

Dried Ground Blood.—Blood is offered at around $7.75 to $8.00 per unit of ammonia ($9.42 to $9.72 per unit N) in bulk, f.o.b. Chicago area, with the market quiet. The New York market is around $8.00 to $8.25 per unit of ammonia ($9.72 to $10.02 per unit N).

Potash.—Demand continues heavy and shipments are moving steadily against contracts. Inclement weather conditions are delaying construction on a new plant, making the time of increased production indefinite. No change in price has been noted.

Phosphate Rock.—Principal movement is against existing contracts. With the increased call for superphosphate, movement of phosphate rock is expected to increase accordingly.

Superphosphate.—Movement of spring needs is in full swing and shipments are at seasonal dimensions. Supply of normal superphosphate is very well balanced against demand, but the market on triple superphosphate is tight, due to short supply in relation to the demand.

Sulphate of Ammonia.—This article continues extremely tight with demand far in excess of supply. It is reported that production during 1948, exclusive of anhydrous ammonia production of sulphate, was approximately 2.7 per cent over 1947.

Ammonium Nitrate.—The tight supply situation shows relatively no change and no recent change in price has been noted.

Nitrate of Soda.—The market continues relatively the same. Demand is active and available supplies are being steadily shipped consumers. to

CHICAGO

Further Decline in Organics Prices Reported. Long Range Position Uncertain. Interest in Spot Material Only

Exclusive Correspondence to "The American Fertilizer"

CHICAGO, February 28, 1949.

Since the last report on animal ammoniates in the midwest markets, the prices have declined further but are now in a rather firm position at the newly established levels. There is, however, still some uneasiness as to the long range position, and buying interest is generally confined to material for nearby shipment.

Digester tankage is selling at $95.00 to $100.00 per ton depending upon location, and while $100.00 per ton is the general asking price for meat scraps, trading in most cases is

done at $5.00 per ton lower. Dry rendered tankage runs from $1.75 to $1.80 per unit of protein delivered. Wet rendered tankage $7.75 to $8.25 per unit of ammonia ($9.42 to $10.02 per unit N), delivered, depending upon quality, and dried blood $7.75 to $8.00 per unit of ammonia ($9.42 to $9.72 per unit N). Steamed bone meal, $70.00 to $75.00 per ton and raw bone meal $65.00 per ton.

PHILADELPHIA

Demand for Chemical Nitrogen More Urgent. Tonnage of Mixed Goods May Drop. Superphosphate and Potash Situation Unchanged

Exclusive Correspondence to "The American Fertilizer"

PHILADELPHIA, March 28, 1949.

Inquiries for chemical nitrogen have increased and are more urgent, but transactions are fairly limited in number, due to high prices. Mixed goods are moving more actively, but it is feared the tonnage will be less than last season, and in fact less than the actual consumer requirements.

Sulphate of Ammonia.—Demand continues ahead of the supply, and only very limited resale quantities appear on the market. Movement from the producing plants is almost entirely against existing contracts.

Nitrate of Soda.—Inquiries are increasingly numerous, but the supply is still inadequate. A few offerings have been reported in the secondary market at $70.00 to $75.00 per ton.

Ammonium Nitrate.—The demand is very active, but nothing is offered other than limited quantities of technical chemical grade.

Castor Pomace.—This material can be had for prompt and nearby delivery at $21.00 per ton, in bags.

Blood-Tankage-Bone.—The organics market is on the decline. High grade tankage has been sold as low as $7.00 per unit of ammonia ($8.51 per unit N). Blood is quoted nominally at $8.00 to $8.50 per unit of ammonia ($8.51 per unit N). Blood is quoted nominally at $8.00 to $8.50 per unit of ammonia ($9.72 to $10.33 per unit N). Bone meal continues ver scarce with limited offerings at $65.00 to $75.00, depending on the grade.

Fish Scrap.—Menhaden meal for prompt delivery is practically unobtainable. Unground scrap for delivery when caught is quoted at $125.00.

Phosphate Rock.—Deliveries are becoming more normal as superphosphate shipments move out. Production keeps well up with the demand for both home consumption and export.

Superphosphate.—Prices remain steady at former levels, and seasonal movement against contracts is now actively under way.

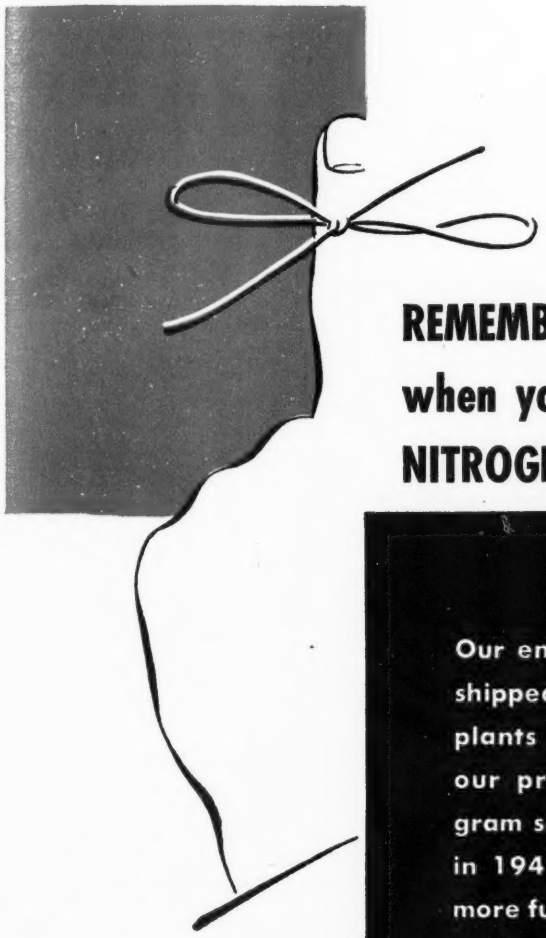
Potash.—Demand continues somewhat ahead of supply, with production moving freely to contract consumers.

Indiana Fertilizer Use Increasing Steadily

Indiana fertilizer sales have tripled during the past 10 years, according to a recent bulletin issued by the Indiana Agricultural Extension Service.

"The tonnage, as based on the State tag sales, amounted to 800,151 tons in 1947 as compared with 274,640 tons in 1937," the report says. "The tonnage for 1948 was 916,994. The report of the State chemist, Dr. F. W. Quackenbush, head of the department of agricultural chemistry, shows that fertilizer applications have increased steadily since 1940. The greatest advance was after the close of the war, when in 1945, according to tag sales, 558,213 tons were applied on Indiana farms.

"The State chemist points out that the



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- Ammonium Nitrate Fertilizer
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pounds of actual plant food per ton, however, had dropped slightly in this period as 497 pounds of plant food were reported per ton in 1947, while 507 pounds were reported in 1937. However, fertilizer quality has improved over 1920, the first year included in the report, when only 318 pounds of plant food were contained in each ton.

"The cost per pound of plant food has increased only moderately from 0.065 cents a decade ago, to 0.076 cents in 1947. But the same value cost the farmer almost double in 1920—0.116 cents.

"The importance of the fertilizer industry is reflected by the retail sales in 1947 which reached $30,331,055 from a $9,123,514 business 10 years before. The increase is due, in major part, to volume as the increase in cost per ton on the average has amounted only to $4.69 a ton. It is significant that back in 1920, a ton of fertilizer on the average cost only 0.89 cents less than in 1947.

"Fertilizer supply is just now starting to catch up with the demand and it is probable that the present high level tonnage of fertilizer sales in Indiana will continue if farm prices are maintained at a reasonable level. It is still advisable for farmers to order their fettilizer and accept delivery early in order to be sure it will be available when needed."

V-C Directors To Submit Recapitalization Plan

The board of directors of the Virginia-Carolina Chemical Corporation has voted to submit a recapitalization plan to stockholders at a special meeting on March 29th. The plan, designed to eliminate a large accumulation of dividend arrears on the corporation's six per cent preferred stock, would involve an agreement of merger with an unnamed wholly owned subsidiary.

Each share of the present preferred stock would receive two shares of new $50 par first preferred stock $3 series A. one share of new $1 par value second preferred stock with a $2 dividend cumulative to the extend earned, and $1.50 in cash. Arrearages on the six per cent preferred totaled $77.50 per share on the 213,052 shares outstanding on January 1st.

The new second preferred stock would be convertible into four shares of new common stock and is redeemable at $76 per share, plus accumulated dividends. The common stock would be entitled to a sinking fund of 15 per cent of net earnings after the second preferred dividend.

Engineers from India Study Fertilizer Plant Operation

Engineers employed by the Indian Government have arrived in the United States for an extended period of intensive training in the operation, maintenance, and production phases of some of North America's largest fertilizer manufacturing plants.

At the end of their training period these men will return to India to take over operation of a new $50,000,000 fertilizer plant at Sindri. The Sindri plant was engineered by Chemical Construction Corporation, a unit of American Cyanamid Company, and the equipment was purchased and erected by the Power-Gas Corporation, Ltd., of Britain. It will be operated by Chemical Construction Corporation engineers until such time as the Indian engineers are trained sufficiently to take over management duties.

The six engineers will be here for several months, during which time they will receive practical instruction in fertilizer plants of the North American Cyanamid Company, Ltd. in Niagara Falls, Ontario, Canada, and Welland, Ontario, Canada.

Shell Consolidates Sales Of Agricultural Products

The formation of a new agricultural department to consolidate the marketing of all Shell Oil Company and Shell Chemical Corporation agricultural products has been announced by L. V. Steck, marketing vice-president of Shell Chemical Corporation. The expanded agricultural unit now becomes a department of Shell Chemical Corporation with administrative offices at 50 West 50th Street, New York. It will direct national sales of anhydrous am-

monia, sulphate of ammonia, soil fumigants, insecticides and herbicides.

F. W. Hatch will be in charge of the new consolidated agricultural products department. He formerly directed insecticide and herbicide sales as manager of Shell Oil's special products department at San Francisco, Assistant manager will be L. F. Stayner, formerly with special products in San Francisco and a past president of the Pacific Insecticide Institute.

The marketing of agricultural products east of the Rockies will be handled by the eastern division agricultural products department, located at 500 Fifth avenue, New York, and headed by E. E. Heuermann. For the west coast, G. W. Huldrum, Jr. will be agricultural products department manager, western division, with headquarters in San Francisco. He will be aided by E. F. Bashor and F. G. Steward.

Mexican Fertilizer Company Plans Expansion

Guanos y Fertilizantes de Mexico, S. A., a fertilizer company sponsored by the Mexican government, has been empowered to enlarge its sphere of operations to include the manufacture of synthetic and inorganic fertilizers, according to recent United States consular reports. The principal plant in the expanded operation will be a nitrogenous fertilizer works to be built near Cuautitlan.

The concern now operates a guano unit at Guadalajara and a superphosphate plant at San Luis Potosi. An affiliated plant in Mexico City is making glue and bone meal, the latter a byproduct which is mixed with ammonium nitrate and sold as fertilizer. The superphosphate factory imports phosphate rock from the United States and obtains sulphuric acid from the local smelter of a United States company. It has an average daily production of 60 metric tons.

Lozier of St. Regis Paper Urges Foreign Technical Cooperation

Kenneth D. Lozier, vice-president of St. Regis Sales Corporation, recently urged that the United States political foreign relations policy be implemented with an enlightened policy of industrial foreign relations to aid economically floundering nations.

Speaking at the Rollins College Economic Conference at Winter Park, Fla., Mr. Lozier, who for some years has directed advertising sales promotion and public relations for St. Regis Paper Company asserted:

"If Europe is to pull herself up to a level of industrial and agricultural stability, she must be helped by this country, not necessarily by outright grants of money and materials, but by technical assistance to show her how to make the best use of her natural resources, to attain a degree of economic stability that will make the world a better place in which to live."

In a mutual pooling of industrial knowledge and experience, Mr. Lozier said, there would be much that we could learn from other nations.

He cited St. Regis Paper Company and others in the paper industry, itself sixth largest in the country, as an example of technical assistance of mutual benefits among nations, pointing out that many of the modern paper making machines stemmed from a program of technical interchanges such as St. Regis is carrying on with its licensees and customers in Europe and South America.

"In this cooperative effort," he said, "we make known to our overseas associates latest developments in manufacturing and processing, information on new papers for packaging different materials, improved bag construction, progress in making plastics from paper, and offer employee training as-

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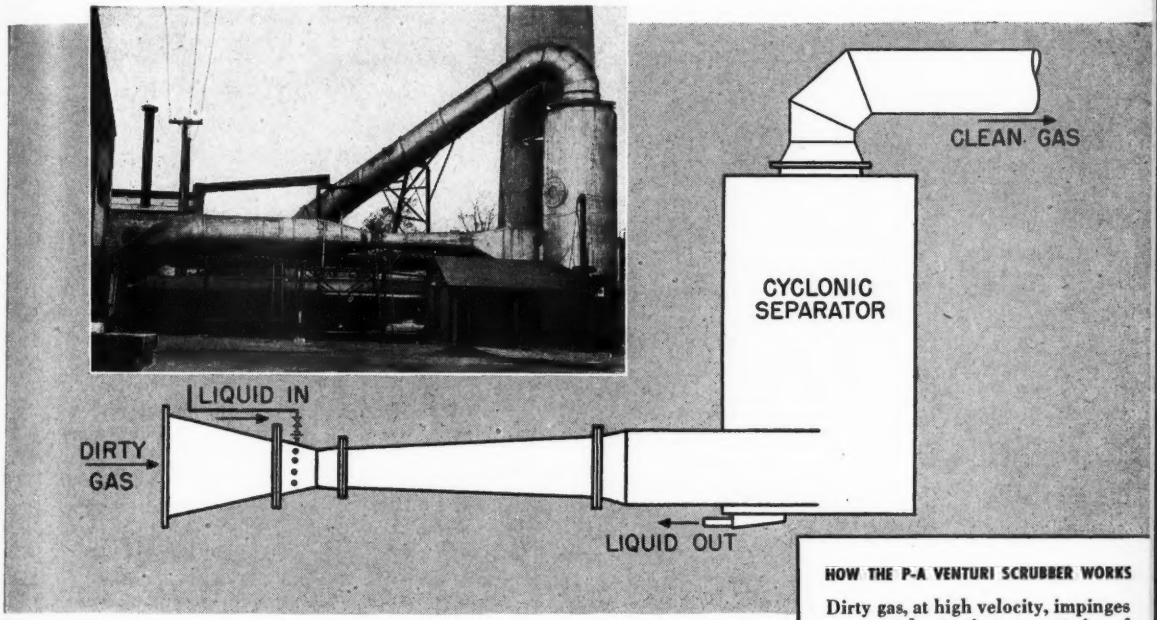

HOW THE P-A VENTURI SCRUBBER WORKS

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sistance and many other types of information that will help them for our mutual advantage.

"Expand this kind of technical aid to encompass U. S. industry as a whole," Mr. Lozier added, "and you will have the pattern for a broad educational program to back up our national foreign relations policy, to implement the vast sums and the huge shipments of materials we are sending overseas."

Mr. Lozier, in citing the things the paper industry might do to help world development through scientific tree farming, interchange of technical information, and development of machinery and equipment, said other industries as well have notably influenced the shaping of world economy, culture and politics—the list is as long as it is impressive.

Tracing the paper industry history, Mr. Lozier pointed out that the United States, north and south, favored geographically by climate, has great stands of coniferous trees and bountiful water power, an indispensable combination. It is the largest pulp and paper producing and consuming country in the world. Russia has more pulp trees than the U. S. and Canada combined, but not the useable water power or technical know-how to match our production. She further is hindered by long overland transportation hauls.

United States' per capita paper consumption last year was 350 pounds, as compared with less than one-half pound per person in China, where the art of paper making originated centuries ago. Yet China has as many people employed in making paper as does the U. S., Mr. Lozier stated.

He suggested that not only the efficiency and productivity of a nation could be measured by paper consumption, but also a nation's progressiveness in education and producing and acquiring material possessions.

For thousands of years, influenced strongly by the pattern of global geography, paper has exercised a profound effect upon world politics, world culture, and world economics, Mr. Lozier said, adding that there seems to be no other single business enterprise which so essentially serves industry as a whole, in all its fields and branches, as does the paper industry.

For instance, he mentioned the fact that paper packaging, such as the St. Regis multiwall paper bags, and the machinery to implement packagng, conveys raw materials and the finished products of industry and business. Paper is essential for the records which must be kept if industry is to operate. Paper checks and paper money are vital. Singling out a specific use for paper, he cited the plastics industry materials ranging from insulation in the inner doors of refrigerators to brightly colored table tops in kitchens.

"Probably most important," he stressed, "the things we know, have learned, the philosophy of free enterprise which the United States is giving to the world, all depemd upon paper.'

Mr. Lozier pointed out that we in the U. S. do not possess a monopoly of technical knowledge and mechanical skill.

"Other nations also possess natural resources—many in abundance greater than ours—knowledge and skills," he said. "But individually, as separate nations, they are situated in the world geographic scheme of things as would be Florida, Maine, Michigan, New York, New England and other states, if these were separate political and economic entitlies, without common cause, a common bond to tie them together in a pooling of industrial interests.'

Mr. Lozier suggested that the economics of world geography have conspired to pit two enormously powerful nations, the United States and Russia, against each other in a contest to see which one is to become the dominant factor in world affairs—the Russian concept to rule the world by forcibly imposing her ideology upon her people and others; the United States seeking to keep world peace by demonstrating to other nations the advantages of the free enterprise system in developing industrial capacity.

Let us hope, Mr. Lozier concluded, that the European and other nations, faced with a choice between the two will come to the realization that combining their productive resources in a federated economy is not only a highly desirable step to take, but that it is a necessary step if human decency and dignity are to be perpetuated in the Old World.

MINERAL AND NITROGEN NUTRITIONAL RELATIONSHIPS IN PLANTS AND SOIL

(Continued from page 8)

sequently, the increase in yield must have been due to the balance of ions in the plant.

With a Bayboro silt loam containing 67 pounds of replaceable potash per acre, the maximum yield (349 bushels) of Irish potatoes was not obtained until 400 pounds of potash per acre had been applied. With an Elkton silt loam, under the same conditions of experimentation, carrying 175 pounds of replaceable potash per acre, 396 bushels were obtained when 100 pounds of potash per acre were applied. A Sassafras fine sandy loam with 163 pounds of replaceable potash per acre yielded 370 bushels of potatoes without any potash fertilization. In other words, the difference in availability of the potash in the Elkton, Sassafras and Bayboro soils, even though the potash was replaceable by neutral salts, was influenced by other ions in the soil and was not effective in increasing crop yield in the Bayboro and Elkton soils. It took 467 pounds of replaceable potash in the Bayboro to produce the same amount of potatoes that 275 pounds produced in the Elkton and 163 pounds produced in the Sassafras.

Another example of the influence of the various ions or balance of ions was shown in a study of sea-water flooded soils that had a salt concentration so high that seeds of spinach, wheat and other crops would not germinate. Seeds germinated readily when light applications of gypsum and other calcium salts were added.

The question of balance of nutritional elements and the presence of other elements in the soil and plant are of tremendous importance in crop growth.

Interrelationship of Elements in Plants

It has been observed in hundreds of cases that where the phosphorus content of the plant is low, nitrogen in the nitrate form accumulates in the plant. Likewise, where a lack of phosphorus stunts the growth, potash and other minerals are likely to be accumulated in the plant. Plants grown under different conditions, e. g., in the presence of different concentrations of nutrients in the soil or under different climatic conditions, vary considerably in composition of most of the elements absorbed and accumulated by the plant.

The total amount of cations—calcium, magnesium, potassium and sodium—tend to reach a constant factor in plants of any specific crop but vary in relation to each other. For tomatoes, on a chemically equivalent basis, it amounts to the factor 1.465 milliequivalents per gram of dry puree. However, if the potash supply of the soil is raised, there tends to be more potash absorbed by the plant at the expense of calcium and magnesium. If the calcium, or calcium and magnesium, supply is increased, the potash content of the plant is somewhat lowered. An increase in calcium and magnesium in the soil causes a lesser amount of the heavy metals to be absorbed by the plant. This is particularly true for manganese, copper, iron and zinc. Observations have also been made that a high potassium content tends to depress the amount of manganese absorbed by the plant. Since these minerals are involved in the metabolism of the plant, certain compounds in the plant contain the mineral elements as part of the molecular structure. Other constituents requiring certain of these mineral elements for manufacture and translocation in the plant, are decidedly influenced by off-balance conditions.

In studies of vitamin C in oats, tomatoes and other crops, it has been observed that manganese had a greater influence in soils low in potash than in soils high in potash in increasing the vitamin-C content and maintaining the vitamin C against depression by the addition of large units of nitrogen. It is possible, therefore, that the presence of large amounts of potassium in the plant is influencing the reaction of manganese. When growing tomatoes in a soil extremely low in available manganese, increasing the concentrations up to approximately 5 pounds of available water-soluble manganese per acre increased the vitamin-C content. Larger amounts of manganese or unbalanced conditions depressed the vitamin-C content.

Excessive concentrations of potassium in the plant probably interfere with the reaction of magnesium in the formation of the chlorophyl. Differences in concentrations of nitrogen, phosphorus and sulphur influence the protein formation in the plant. These illustrations point out the effects that certain ions have upon the absorption, utilization and activity of the ions in the plant.

The unbalanced condition in certain soils and plants undoubtedly serves to explain the very great differences in yields obtained by growers in a community in which the soil type and rainfall conditions are the same. There is a tremendous need for concentrated study in this field of nutrient relationships in the soil and plants and their effect upon

each other. There is urgent need for studies in which all conditions are taken into consideration and complete chemical analyses of the plants and soils are made to ascertain the differences.

The above discussion justifies the conclusion that the manufacture of a particular fertilizer grade from different materials and with different chemical analyses may be desirable. A large number of different fertilizer grades is not necessary, but grades that vary materially such as 5–10–10, 4–12–8, 6–6–12, 0–12–12, 3–9–12, 10–0–20, 10–5–5, 7–7–7, supplemented by the use of unmixed materials, when necessary, are very desirable. The most effective use of these fertilizer mixtures is accomplished through the knowledge of the nutritional status of the soil and a knowledge of the requirements of the plant to be grown.

ORGANIC MATTER PUTS NEW LIFE IN OLD SOILS

(Continued from page 10)

higher under grass than when land is under cultivation."

We should not hope to restore our soils to their virgin content of organic matter, nor is it necessary that we do so. The soils of Europe have been cultivated for over a thousand years and they are still producing good crops, that is, where given adequate amounts of lime and commercial plant foods and a program of good soil and crop management is followed. There are thousands of well-managed farms in Wisconsin where crop production is being maintained at high levels, and yet the organic-matter content of soils on these farms has been reduced a good 40 per cent under that which they contained when the land was virgin.

At the other extreme, there are soils on farms where the organic matter has been completely burned out as a result of the combined effects of plant-food depletion and bad cropping practices. Such farms with any appreciable degree of slope have suffered heavy losses by soil erosion, too.

Progress Being Made

However, farmers are doing a better job of managing and handling their soils than they did 15 years ago. The Soil Conservation Service and the Extension Service of our colleges have been preaching and demonstrating the better practices of soil conservation and fertility maintenance. The AAA (now known as the Production and Marketing Administration) has made a tremendous contribution toward a program of soil conservation. The Federal government has made a capital investment in the future welfare of the country by this program—an investment that will pay big dividends in years to come.

A recent letter from a relative who has lived the 62 years of his life on the black prairies of central Iowa, tells me of the great interest farmers are now taking in better soil-saving practices. "Yes," he wrote, "we have farmed her hard out here in Iowa. These old soils aren't what they used to be; and you known it's hard to believe it, but the soils out here are really responding to fertilizer. We've got to come to it." He went on to say that in more recent years he and his neighbors had been plowing down clover for their corn crops.

These vaunted prairie soils of Iowa—soils which the natives used to say would never wear out—are now responding to treatment with fertilizer. Farmers are finding that fertilizers are producing substantial increases in yields of corn, grain, and hay.

Middle West Improving

We have "farmed her hard" throughout this Middle West, and the time has come when we must pour back some of the fertility that has been pumped out over the past 70 to 100 years. Evidence that farmers have drawn heavily on their soil bank account is seen in the fact that they do get these big increases in crop yields from the use of commercial fertilizers. New factories are being built all over the Middle West—7 new plants in Wisconsin, 6 or 7 new plants in the State of Iowa, and several new plants in Minnesota, Illinois, and other Midwestern states.

The great movement toward a grassland type of agriculture has become a part of the thinking of farmers in the Middle West. "More land in grass more of the time; some land in grass all of the time" is the slogan we use here in Wisconsin. Our Government is encouraging farmers to practice a soil-saving type of agriculture by making incentive payments for practices of fertilizing, liming, the seeding of grass and legume crops, soil-conserving tillage practices, and other control measures.

How important is organic matter? I hope that every farmer will decide upon and then carry out some improved practices on his farm that will add to the supply of humus and organic matter. Such procedure will make his land more productive, add to its capital value, and make for future prosperity for him, his family, his community, his state, and the Nation.

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Fulton Bag & Cotton Mills, Atlanta, Ga.
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BAG MANUFACTURERS—Cotton
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Jaite Company, The, Jaite, Ohio
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Sturtevant Mill Company, Boston, Mass.

BONE BLACK
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Huber & Company, New York City

BONE PRODUCTS
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Davidson Commission Co., The, Chicago, Ill.
Huber & Company, New York City
Jackle, Frank R., New York City
McIver & Son, Alex M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

BORAX AND BORIC ACID
American Potash and Chem. Corp., New York City

BROKERS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Davidson Commission Co., The, Chicago, Ill.
Huber & Company, New York City
Jackle, Frank R., New York City
Keim, Samuel D., Philadelphia, Pa.
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

BUCKETS—For Hoists, Cranes, etc.
Hayward Company, The, New York City

BUCKETS—Elevator
Baughman Manufacturing Co., Jerseyville, Ill.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CARS AND CARTS
Atlanta Utility Works, The, East Point, Ga.
Hough Co., The Frank G., Libertyville, Ill.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHEMICALS
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Commercial Solvents Corp., New York City
Davison Chemical Corporation, Baltimore, Md.
Huber & Company, New York City
International Minerals & Chemical Corporation, Chicago, Ill
Lion Oil Company, El Dorado, Ark.
McIver & Son, Alex. M., Charleston, S. C.
Spencer Chemical Co., Kansas City, Mo.
Virginia-Carolina Chemical Corp., Richmond, Va.
Woodward & Dickerson, Inc., Philadelphia, Pa.

CHEMISTS AND ASSAYERS
Gascoyne & Co., Baltimore, Md.
Shuey & Company, Inc., Savannah, Ga.
Wiley & Company, Baltimore, Md.

CONDITIONERS
Arkansas Rice Growers Corp. Assn., Stuttgart, Ark.
Jackle, Frank R., New York City
Keim, Samuel D., Philadelphia, Pa.
Quaker Oats Company, Chicago, Ill.

COTTONSEED PRODUCTS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Huber & Company, New York City
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

CYANAMID
American Agricultural Chemical Co., New York City
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City

DRYERS
Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.
Titlestad Corporation, Nicolay, New York City

FERTILIZER (Mixed) MANUFACTURERS
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Davison Chemical Corporation, Baltimore, Md.
International Minerals & Chemical Corporation, Chicago, Ill.
Southern States Phosphate & Fertilizer Co., Savannah, Ga
Virginia-Carolina Chemical Corp., Richmond, Va.

FISH SCRAP AND OIL
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Huber & Company, New York City
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

FOUNDERS AND MACHINISTS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Machine Works, Aurora, Ind.

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

HOPPERS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Southern States Phosphate & Fertilizer ., Savannah, Ga.
Woodward & Dickerson, Inc., Philadelphia, Pa.

INSECTICIDES
American Agricultural Chemical Co., New York City

LEAD BURNERS
Southern Lead Burning Co., Atlanta, Ga.

LIMESTONE
American Agricultural Chemical Co., New York City
Ashcraft-Wilkinson Co., Atlanta, Ga.
McIver & Son, Alex. M., Charleston, S. C.

LOADERS—Car and Wagon
Hough Co., The Frank G., Libertyville, Ill.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making and Handling
Atlanta Utility Works, The, East Point, Ga.
Chemical Construction Corp., New York City
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Ammoniating
Sackett & Sons Co., The A. J., Baltimore, Md.
Sturtevant Mill Company, Boston, Mass.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, The, East Point, Ga.
Baughman Manufacturing Co., Jerseyville, Ill.
Hough Co., The Frank G., Libertyville, Ill.
Hayward Company, The, New York City
Link-Belt Co., Chicago, Ill.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.

MACHINERY—Grinding and Pulverizing
Atlanta Utility Works, The, East Point, Ga.
Bradley Pulverizer Co., Allentown, Pa.
Kent Mill Co., Brooklyn, N. Y.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.

MACHINERY—Material Handling
Atlanta Utility Works, The, East Point, Ga.
Baughman Manufacturing Co., Jerseyville, Ill.
Hayward Company, The, New York City
Hough Co., The Frank G., Libertyville, Ill.
Link-Belt Co., Chicago, Ill.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.

MACHINERY—Mixing, Screening and Bagging
Atlanta Utility Works, The, East Point, Ga.
Link-Belt Co., Chicago, Ill.
Sackett & Sons Co., The A. J., Baltimore Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.

MACHINERY—Power Transmission
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Superphosphate Manufacturing
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.

MANGANESE SULPHATE
McIver & Son, Alex. M., Charleston, S. C.

MINOR ELEMENTS
Tennessee Corporation, Atlanta, Ga.

MIXERS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.

NITRATE OF SODA
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Huber & Company, New York City
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.

NITROGEN SOLUTIONS
Lion Oil Company, El Dorado, Ark.
Spencer Chemical Co., Kansas City, Mo.

NITROGENOUS ORGANIC MATERIAL
American Agriculture Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Davidson Commission Co., The, Chicago, Ill.
Huber & Company, New York City
International Minerals & Chemical Corporation, Chicago, Ill.
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.

PHOSPHATE ROCK
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Huber & Company, New York City
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Virginia-Carolina Chemical Corp., Richmond, Va.

PLANT CONSTRUCTION—Fertilizer and Acid
Atlanta Utility Works, The, East Point, Ga.
Chemical Construction Corp., New York City
Monsanto Chemical Co., St. Louis, Mo.
Sackett & Sons Co., The A. J., Baltimore, Md.
Southern Lead Burning Co., Atlanta, Ga.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.
Titlestad Corporation, Nicolay, New York City

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Huber & Company, New York City
International Minerals & Chemical Corporation, Chicago, Ill.
Jackle, Frank R., New York City

POTASH SALTS—Manufacturers
American Potash and Chem. Corp., New York City
Potash Co. of America, New York City
International Minerals & Chemical Corporation, Chicago, Ill.
United States Potash Co., New York City

PRINTING PRESSES—Bag
Schmutz Mfg. Co., Louisville, Ky.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.

REPAIR PARTS AND CASTINGS
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

BUYERS' GUIDE

Stedman's Foundry and Mach. Works, Aurora, Ind.

SCALES—Including Automatic Bagging
Atlanta Utility Works, The, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SCREENS
Atlanta Utility Works, The, East Point, Ga.
Link-Belt Co., Chicago, Ill.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.
Sturtevant Mill Company, Boston, Mass.

SEPARATORS—Air
Kent Mill Co., Brooklyn, N. Y.
Sackett & Sons Co., The A. J., Baltimore, Md.
Sturtevant Mill Co., Boston, Mass.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SULPHATE OF AMMONIA
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Huber & Company, New York City
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

SULPHUR
Ashcraft-Wilkinson Co., Atlanta, Ga.

SULPHURIC ACID
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Huber & Company, New York City
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Southern States Phosphate Fertilizer Co., Savannah, Ga.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Virginia-Carolina Chemical Corp., Richmond, Va.

SUPERPHOSPHATE
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, G.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Davison Chemical Corporation, Baltimore, Md.
Huber & Company, New York City
International Minerals & Chemical Corporation, Chicago, Ill.
Jackle, Frank R., New York City
Southern States Phosphate Fertilizer Co., Savannah, Ga.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Virginia-Carolina Chemical Corp., Richmond, Va.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Minerals & Chemical Corporation, Chicago, Ill.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Virginia-Carolina Chemical Corp., Richmond, Va.

TAGS
Keener Mfg. Co., Lancaster, Pa.

TANKAGE
American Agricultural Chemical Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City
Davidson Commission Co., The, Chicago, Ill.
International Minerals & Chemical Corporation, Chicago, Ill.
Jackle, Frank R., New York City
McIver & Son, Alex. M., Charleston, S. C.
Woodward & Dickerson, Inc., Philadelphia, Pa.

VALVES
Atlanta Utility Works, The, East Point, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

Alphabetical List of Advertisers

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POTASH COMPANY OF AMERICA

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SOUTHERN SALES OFFICE . . Candler Building, Atlanta, Ga.

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Double Sulfate of Potash-Magnesia

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Sul-Po-Mag is produced exclusively by International from langbeinite ores at its Carlsbad, New Mexico, mines and is available in larger quantities than ever before. *Sul-Po-Mag* is now extensively supplied by fertilizer manufacturers in mixed plant foods and for direct application.

When you tell your farm customers that you are using *Sul-Po-Mag*, you will find many of them familiar with it. For *Sul-Po-Mag* has been advertised consistently for nearly four years in farm papers, now reaching more than 3,365,000 farmers.

SUL-PO-MAG (Water Soluble Double Sulfate of Potash-Magnesia) • MURIATE OF POTASH • SULFATE OF POTASH

SUL-PO-MAG TRADEMARK REG. U. S. PAT. OFF.

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